DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE CIVIL ENGINEER SUPPORT AGENCY

SEP 27 1999

FROM: AFCESA/CES
139 Barnes Drive, Suite 1
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SUBJECT: **Engineering Technical Letter (ETL) 99-7, Airfield Pavement Condition Assessment Standards**

1. Purpose. This ETL provides a standard procedure for identifying/validating airfield pavement projects for the Facility Investment Metric (FIM); prioritizing projects within FIM categories; and assigning a "health" rating to pavement facilities (runways, taxiways, aprons), or to entire airfields. It was developed in response to a need to develop an objective method to determine facility impact ratings and prioritize multiple requirements to repair airfield pavements. The basic element of the assessment is the Pavement Condition Index (PCI), modified by structural capability, skid potential, and foreign object damage (FOD) potential.

Note: This ETL is for guidance only.

2. Application: All Air Force organizations conducting surveys of airfield pavements.

2.1. Authority: AFPD 32-10, *Installations and Facilities,* and AFI 32-1041, *Airfield Pavement Evaluation.*

2.2. Effective Date. Immediately.

2.3. Expiration: Five years from date of issue.

2.4. Ultimate Recipients: Base Civil Engineers and MAJCOMs conducting facility assessments for FIM.

3. Referenced Publications.

3.1. Air Force:

- *Air Force Facility Investment Metric Implementation and Operations Guide*, 1 August 1997
- AFI 32-1032, *Planning and Programming Real Property Maintenance Projects*
- AFI 32-1041, *Airfield Pavement Evaluation*
- AFR 93-5/TM 5-826-6, *Procedures for U.S. Army and U.S. Air Force Airfield Pavement Condition Surveys* (will be superseded by AFMAN 32-1121V3(I)).
- ETL 97-14, *Procedures for Airfield Pavement Condition Index Surveys*

3.2. Private Industry:

- American Society for Testing and Materials (ASTM) D 5340-93, *Test Method for Airport Pavement Condition Index Surveys*
- Federal Aviation Administration (FAA) Advisory Circular (AC) No: 150/5320-12C, *Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces*, 18 March 1997

4. Acronyms and Terms.

AC	–	asphalt concrete
ACN	–	aircraft classification number
AFIT	–	Air Force Institute of Technology
ASTM	–	American Society for Testing and Materials
CERL	–	Civil Engineering Research Laboratory
FAA	–	Federal Aviation Administration
FIM	–	Facility Investment Metric
FOD	–	foreign object damage
GIS	–	Geographical Information System
M&R	–	maintenance and repair
MAJCOM	–	major command
MARM	–	Mission Area Requirements Matrix
Micro PAVER	–	pavements management software incorporating GIS used by DoD, government, and private industry
PCC	–	portland cement concrete
PCI	–	Pavement Condition Index
PCN	–	Pavement Classification Number
USACE	–	United States Army Corps of Engineers

5. Overview.

5.1. Criteria.

5.1.1. Facility Categories. The Base/MAJCOM determines the appropriate category for each airfield pavement facility based on *Air Force Facility Investment Metric Implementation and Operations Guide*. Primary pavements (those absolutely necessary to perform the mission) and some other pavements should fall in the "Primary Mission" category.

5.1.2. Facility Ratings. Apply criteria in paragraph 6 to determine or validate the facility rating as "Minimal," "Degraded," or "Critical." There should be numerous projects in each category, with most in the "Primary Mission – Degraded" category of the Mission Area Requirements Matrix (MARM).

5.1.3. Project Priorities. Apply criteria in paragraph 7 to set priorities for projects within each category.

5.1.4. Numerical Rating System. The criteria in paragraph 8 can be used to establish a numerical rating for pavement systems and entire airfields that allows comparison throughout the command and assesses the impact of projects.

5.2. Pavement Condition Surveys. The source for information on condition survey, pavement distress types, and severity levels comes primarily from AFR 93-5/TM 5-826-6, *Procedures for U.S. Army and U.S. Air Force Airfield Pavement Condition Surveys*; ASTM D 5340-93, *Test Method for Airport Pavement Condition Index Surveys*; and ETL 97-14, *Procedures for Airfield Pavement Condition Index Surveys*. Background information is provided here to aid understanding of the pavement rating system and terminology.

5.2.1. PCI Values and Pavement Ratings. Pavements are rated on a scale of 0 (failed) to 100 (perfect, no faults) using a visual assessment system which categorizes distresses in a pavement system by type of distress, density of distress, and severity of the distress. PCI values and associated pavement ratings from AFR 93-5/TM 5-826-6 are shown in Figure 1.

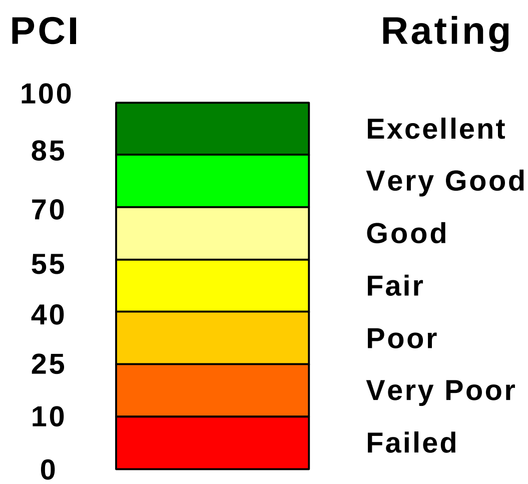

Figure 1. Pavement Rating Scale

5.2.2. When to Conduct Surveys. Bases/MAJCOMS must arrange to conduct condition surveys and assure that most recent condition survey information reflects the condition of the airfield pavement. Where current PCI data does not reflect the true condition of a pavement feature, bases should conduct condition surveys of individual pavement features to assure accurate assessments. Surveys are required every five years in accordance with AFI 32-1041, *Airfield Pavement Evaluation*. In addition, AFI 32-1032, *Planning and Programming Real Property Maintenance Projects using Appropriated Funds (APF)*, requires a PCI for projects submitted to MAJCOMs for approval.

5.2.3. Training and Contractor Support. Pavement condition survey training is available through the Air Force Institute of Technology (AFIT), Wright-Patterson Air Force Base, Ohio; US Army Corps of Engineers Construction Engineering Research Laboratory (USACE-CERL); and the University of Illinois Continuing Education Program. Surveys can be accomplished in-house or by contract. On-call contracts available at HQ AFCESA can also provide these services. MAJCOM pavement engineers should be consulted prior to awarding contracts for surveys and/or training.

5.3. FOD Potential. At certain locations, FOD potential is one of the primary factors for determining the serviceability of a pavement area. To quantify potential FOD problems, a new FOD potential rating was created. The FOD potential is based only on certain pavement distresses, as described in paragraph 6.1.2. FOD potential ratings should be determined from the most current Pavement Condition Survey.

5.4. Skid/Hydroplaning Potential. If a runway surface is wet and lacks good friction resistance, aircraft can hydroplane or experience poor braking performance. AFCESA conducts Friction Characteristics Evaluations to determine the friction along the length of the runway. The criteria used for judging hydroplaning potential come from FAA AC 150/5320-12C, *Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces*.

5.5. Structural Index. Airfield pavements are designed and built to support a certain aircraft load for a number of traffic crossings. After construction, pavements are evaluated to determine the actual thickness and strength of the in-place pavements and supporting soils. AFCESA conducts these evaluations at all Air Force bases approximately every ten years. Using the in-place data, AFCESA calculates a Pavement Classification Number (PCN) for every airfield pavement feature. The structural index is a comparison of the Aircraft Classification Number (ACN) to the PCN.

6. Airfield Pavement Assessment Procedures. This section describes a procedure for identifying or validating maintenance and repair requirements for an airfield pavement (i.e., runway, apron, or taxiway) based on four factors: (1) PCI; (2) FOD potential; (3) skid/hydroplaning potential; and (4) structural index.

6.1. Step One: Determine the Rating Factor for Each Pavement Feature.

6.1.1. PCI. Review the most recent airfield pavement condition survey report. Conduct PCI surveys if the current condition is not accurately reflected in the latest airfield pavement condition survey report.

6.1.2. FOD Potential. Determine the FOD potential of pavement distresses using the PCI survey. Consider only distresses that have a density greater than one percent as determined by the Micro PAVER program, where the scope exceeds in-house repair capability.

6.1.2.1. Distresses Capable of Producing FOD:

(a) Portland cement concrete (PCC) pavement - Blow-up, corner break, joint seal damage, popouts, scaling, spalling (joint and corner), patching, cracking (divided/shattered slabs, longitudinal, diagonal, transverse and durability cracking).

(b) Asphalt concrete (AC) pavement - Alligator cracking, longitudinal and transverse cracking, block cracking, jet blast erosion, joint reflection cracking, oil spillage, patching, raveling/weathering, slippage cracking and shoving.

6.1.2.2. FOD Potential Ratings:

(a) Low FOD potential - The pavement has low severity FOD distresses at any density, and all individual medium or high severity FOD distresses are less than one percent density.

(b) Moderate FOD potential - The pavement has low severity FOD distresses at any density, medium severity FOD distresses at greater than one-percent density, and high severity FOD distresses at less than one percent density.

(c) High FOD potential - The pavement has low and medium severity distresses at any density and high severity distresses at greater than one percent density.

6.1.2.3. FOD Index. Micro PAVER automatically calculates the FOD Index on a scale from 0 to 100, with 0 indicating no FOD potential and 100 indicating maximum FOD potential.

6.1.3. Skid/Hydroplaning Potential. Review the most recent friction characteristics evaluation report for the base runway(s) to determine the skid/hydroplaning potential of runway pavements. Pavements are considered to have low, moderate, or high skid/hydroplaning potential under the friction conditions listed in Table 1.

Table 1. Determining Mu-Meter Values

Skid/ Hydroplaning Potential	Mu-Meter 40 mph	Mu-Meter 60 mph	GripTester® 40 mph	GripTester® 60 mph
LOW	$\geq$ 0.52	$\geq$ 0.38	$\geq$ 0.53	$\geq$ 0.36
[1]**MODERATE**	Between 0.42 and 0.52	Between 0.26 and 0.38	Between 0.43 and 0.53	Between 0.24 and 0.36
[2]**HIGH**	$\leq$ 0.42	$\leq$ 0.26	$\leq$ 0.43	$\leq$ 0.24

[1] Distance of 305 meters (1000 feet) or more
[2] Distance of 152 meters (500 feet) or more

6.1.3.1. In the past, AFCESA has used the Mu-Meter to determine skid/hydroplaning potential. A new testing device, the GripTester®, will be used in the future and has slightly different maintenance planning and minimum friction levels.

Note: GripTester® is a registered trademark of Findlay Irvine Ltd. References to this product/trademark do not imply endorsement by the Air Force.

6.1.3.2. Divide each runway feature into 152-meter (500-foot) segments and determine an average Mu-Meter value for each segment at both testing speeds. Compare that value to Table 1. If the friction value at different speeds indicates two different categories, assign the more severe category to the segment. Assign the lowest segment rating to the entire pavement feature.

6.1.4. Structural Index. Review the latest HQ AFCESA airfield pavement structural evaluation report to determine if any significant portions of the airfield pavement system are overloaded (ACN/PCN > 1.0). A PCN code should be listed for every pavement feature. Pavements are considered overloaded when the ACN/PCN ratio is greater than 1.0. When calculating the ACN/PCN ratio, use an ACN for the most critical mission aircraft at its maximum takeoff weight.

6.2. Step Two: Determine a Rating for Each Feature. Because airfield pavements are mission essential, it is important that the pavement condition be maintained to a high standard. The Air Force has traditionally used a PCI of 70 as the minimum goal. However, other factors, such as friction characteristics for runways, structural adequacy, and FOD potential, are also important considerations. The standard rating procedure for airfield pavements uses the PCI as the basic rating criterion, with adjustments, when these other factors do not meet specified criteria. FIM ratings of "Adequate," "Marginal," or "Unsatisfactory" (can be directly associated with ratings of "Minimal," "Degraded," or "Critical") are assigned to each airfield feature based on the criteria in Table 2.

Example: A feature is rated "Adequate" if the PCI is 70-100, provided that:

- Mu-Meter (40 mph) friction (mu) is greater than or equal to 0.52.
- Mu-Meter (60 mph) friction (mu) is greater than or equal to 0.38.
- ACN/PCN is less than 1.25.
- Distresses associated with FOD are less than 1 percent, and/or are all low severity.

Table 2. Mu-Meter Rating Example

RATING/ ASSESSMENT CATEGORY	Pavement Condition Index (PCI)	Skid/Hydroplaning Potential Friction (Mu) Measurement (Runways Only)	Structural Adequacy ACN/PCN	FOD Potential
Adequate (Minimal)	PCI = 100 PCI > 70	Mu-Meter (40 mph)≥0.52 Mu-Meter (60 mph)≥0.38 Griptester® (40 mph)>0.53 Griptester® (60 mph)>0.36	ACN/PCN<1.25	Medium or high density <1% or low severity FOD distresses
Marginal (Degraded)	PCI > 55	Mu-Meter (40 mph)>0.42 Mu-Meter (60 mph)>0.26 GripTester® (40 mph)>0.43 GripTester® (60 mph)>0.24	1.25<ACN/PCN<1.50	Medium severity FOD distresses, density>1%
Unsatisfactory (Critical)	PCI ≤ 55 or any PCI with associat-ed modifiers	Mu-Meter (40 mph)≤0.42 Mu-Meter (60 mph)≤0.26 GripTester® (40 mph)<0.43 GripTester® (60 mph)<0.24	ACN/PCN≥1.50	High severity FOD distress, density>1%,

Note: FOD potential data may not be readily available. If this is the case, it is recommended that only mu and ACN/PCN modifiers be used. FOD information will be available in future Micro PAVER reports.

6.3. Step Three: Determine Overall Facility Rating. Features may be grouped together as part of one facility or requirement. The rating for the facility or requirement is equal to the lowest rating of the individual features. Tables 3, 4, and 5 show standard pavements assessment examples.

Table 3. Standard Pavements Assessment - Example 1

Facility	Feature	PCI	Mu(40)	Mu(60)	ACN/PCN	FOD	Rating
Runway	R01A	78	0.55	0.40	0.88	<1%	**Adequate**
	R02C	87	**(0.50)**	0.38	0.88	<1%	**Marginal**
	R03A	76	**(0.50)**	0.45	**(1.25)**	<1%	**Marginal**
	R04A	72	**(0.45)**	0.40	**(1.4)**	**(1.5% H)**	**Unsat.**
(#.##): Indicates does not meet "Adequate" requirements							

Runway Overall Rating: Unsatisfactory (lowest feature rating)

Table 4. Standard Pavements Assessment - Example 2

Facility	Feature	PCI	Mu(40)	Mu(60)	ACN/PCN	FOD	Rating
Taxi A	T01A	83	N/A	N/A	1.0	<1 %	**Adequate**
	T02A	**(57)**	N/A	N/A	0.9	<1 %	**Marginal**
Taxi B	T03A	75	N/A	N/A	0.85	<1 %	**Adequate**
Taxi C	T04A	**(59)**	N/A	N/A	1.20	<1 %	**Marginal**
Taxi D	T05A	**(39)**	N/A	N/A	**(1.35)**	**(1.5% H)**	**Unsat.**

Taxiways Overall Rating: Unsatisfactory

Table 5. Standard Pavements Assessment - Example 3

Facility	Feature	PCI	Mu(40)	Mu(60)	ACN/PCN	FOD	Rating
Apron A	A01B	77	N/A	N/A	1.0	<1%	**Adequate**
	A02B	**(59)**	N/A	N/A	1.1	<1%	**Marginal**
Apron B	A03B	72	N/A	N/A	**(1.4)**	**(1.2 % H)**	**Unsat.**

Aprons Overall Rating: Unsatisfactory

6.4. Step Four: Report Ratings**.** Report ratings by facility category code in accordance with *Air Force Facility Investment Metric Implementation and Operations Guide*. It is also recommended the ratings be displayed on a color-coded airfield layout plan with green indicating "Adequate," yellow indicating "Marginal," and red indicating "Unsatisfactory." An example airfield layout plan illustrating the ratings in paragraph 6.2 is shown in Figure 2.

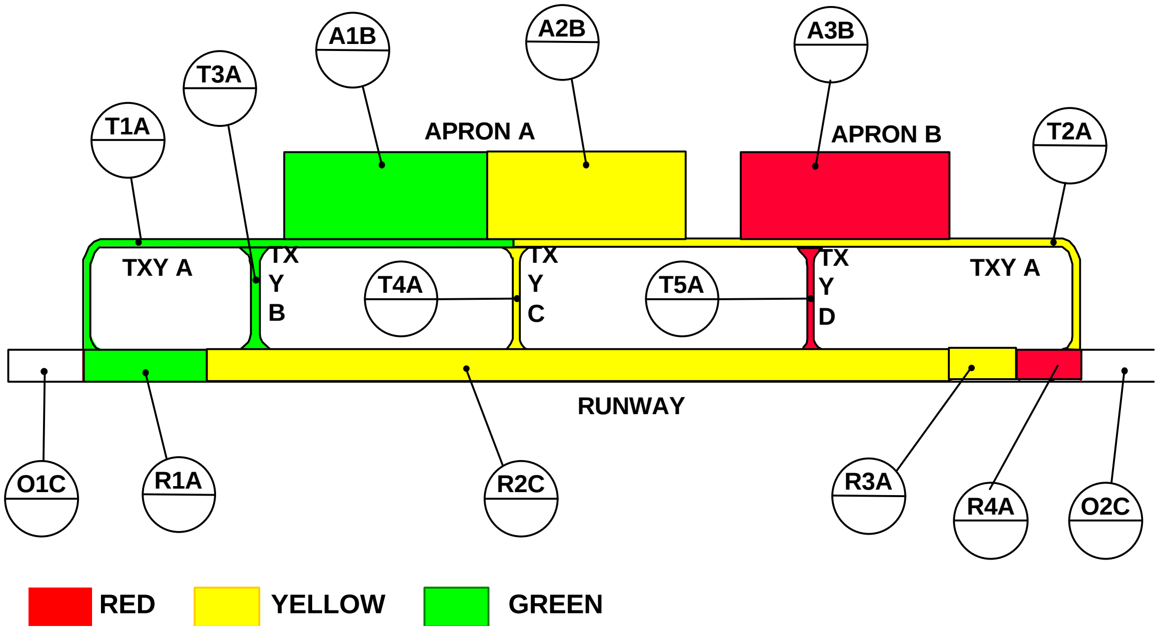

Figure 2. Sample Airfield Layout Plan

7. Priority Ordering of Projects. Paragraphs 7.1 through 7.3 explain a method for objectively establishing priority ordering for several projects that fall into the same category of the MARM.

7.1. Procedure. Determine the PCI, FOD potential, 40-mph Mu-Meter or GripTester®, and ACN/PCN values. Using Figure 3, determine the "deduct value for FOD potential, structural, and skid potential. Subtract each deduct value from the PCI to determine a priority order.

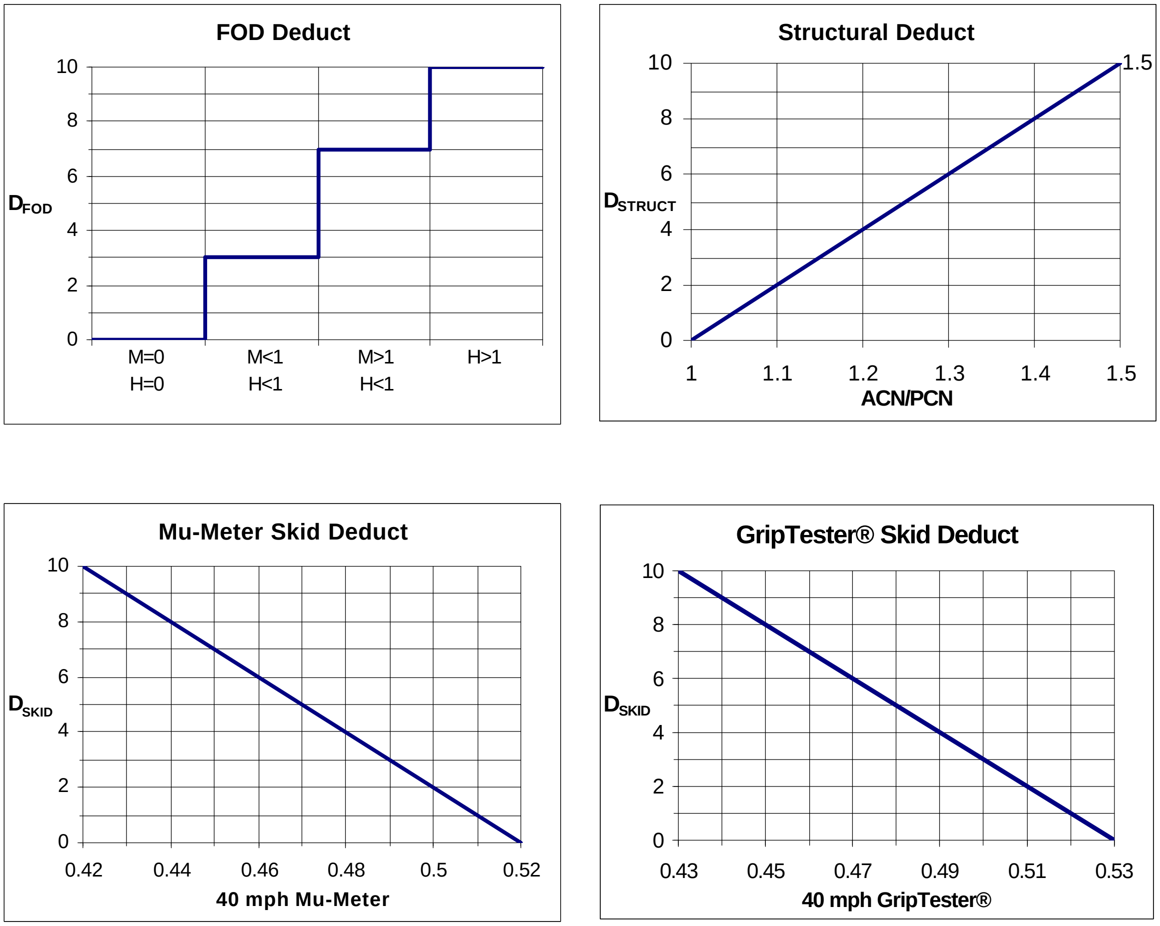

Figure 3. "Deduct Values" for FOD Potential, Structural, and Skid Potential

7.2. Example. Runway features fall within the "Degraded" category as determined by the criteria in paragraph 6.2. Pertinent information for determining the rating is shown in Table 6.

Table 6. Degraded Category Rating Determination

Feature	PCI	Mu(40)	FOD	ACN/PCN
R11A	75	0.48	M=1.5, H=0.5	1.4
R12A	55	0.43	M=1.5	1.3
R13A	55	0.43	M=0.8	1.3

Rating for R11A = 75 – 4 – 7 – 8 = 56
Rating for R12A = 55 – 9 – 7 – 6 = 33
Rating for R13A = 55 – 9 – 3 – 6 = 37
Priority for funding is R12A, then R13A, then R11A.

7.3. Combining Features. When features are combined to form projects, use an area-weighted process for determining the rating. For example, if R12A and R13A were included in a project, the combined rating would be:

$$\text{Rating (Combined)} = \frac{\text{Rating R12A(Area R12A) + Rating R13A(Area R13A)}}{\text{Area R12A + Area R13A}}$$

8. Numerical Rating System. Some MAJCOMs may want to rate the general “health” of all facilities, including pavements, on a numerical rating scale. This section describes a procedure for calculating a pavement rating using a weighted PCI.

8.1. Procedure. Use a weighted PCI to determine the overall rating for a facility. The weighted PCI can be calculated manually or by using Micro PAVER. Assume a 3048- by 46-meter (10,000- by 150-foot) runway with:

- R21A = 304 by 46 meters (1000 by 150 feet)
- R22C = 2438 by 46 meters (8000 by 150 feet)
- R23A = 152 by 46 meters (500 by 150 feet)
- R24A = 152 by 46 meters (500 by 150 feet)

and

- PCI values of 78, 70, 54, and 52, respectively.

The manual computation is as follows:

Weighted PCI =

$$\frac{\text{R21A PCI(R21A Area) + R22C PCI(R22C Area) + R23A PCI(R23A Area) + R24A PCI(R24A Area)}}{\text{R21A Area + R22C Area +R23A Area + R24A Area}}$$

Weighted PCI (metric) =

$$\frac{78(3048m \times 46m) + 70(2438m \times 46m) + 54(152m \times 46m) + 52(152m \times 46m)}{(3048m \times 46m) + (2438m \times 46m) + (152m \times 46m) + (152m \times 46m)}$$

Weighted PCI (western) =

$$\frac{78(10{,}000' \times 150') + 70(8000' \times 150') + 54(500' \times 150') + 52(500 \times 150')}{(1000' \times 150') + (8000' \times 150') + (500' \times 150') + (500' \times 150')}$$

"Health" of runway = 69

8.2. Assessing Value Added. The procedure above can be used to determine value added to a facility by a project. For example, assume an M&R project raised the PCI of

R23A and R24A to 80. The new rating for the runway is 71.8. The project increased the “health “ of the runway by 2.8 points.

8.3. Rating Scales. A MAJCOM may want to use a different scale for rating facility health. For example, it may be desirable to use a range of 85 to 100 for "Adequate." This can be accomplished by applying a proportioning operation to the weighted PCI (see Table 7).

Table 7. Proportioning Operation Applied to the Weighted PCI

Rating	Weighted PCI	Proportioning Operation	Numerical Rating
Adequate (Minimal)	100	→	100
		([PCI-70]x[15/30])+85	
	70	→	85
Marginal (Degraded)	69	→	84
		(PCI-55)+70	
	55	→	70
Unsatisfactory (Critical)	54	→	69
		(PCI-70/55)	
	0	→	0

9. Point of Contact. Mr. Jim Greene, HQ AFCESA/CESC, DSN 523-6334; commercial (850) 283-6334; FAX (850) 283-6219; or internet greenej@afcesa.af.mil (after 1 Oct 99: jim.greene@tyndall.af.mil).

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